

HACKTEX VIRTUAL TRAINING MATERIALS

ADVANCED TEXTILES MANUFACTURING INDUSTRY

Learning unit 2: Raw materials and products for functional and smart textiles

Lesson 2

Raw materials for active textiles

Heura Ventura / Universitat Politècnica de Catalunya

Mònica Ardanuy / Universitat Politècnica de Catalunya



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Innovative smart textiles & entrepreneurship / 2021-1-RO01-KA220-HED-000027527



RAW MATERIALS FOR ACTIVE TEXTILES

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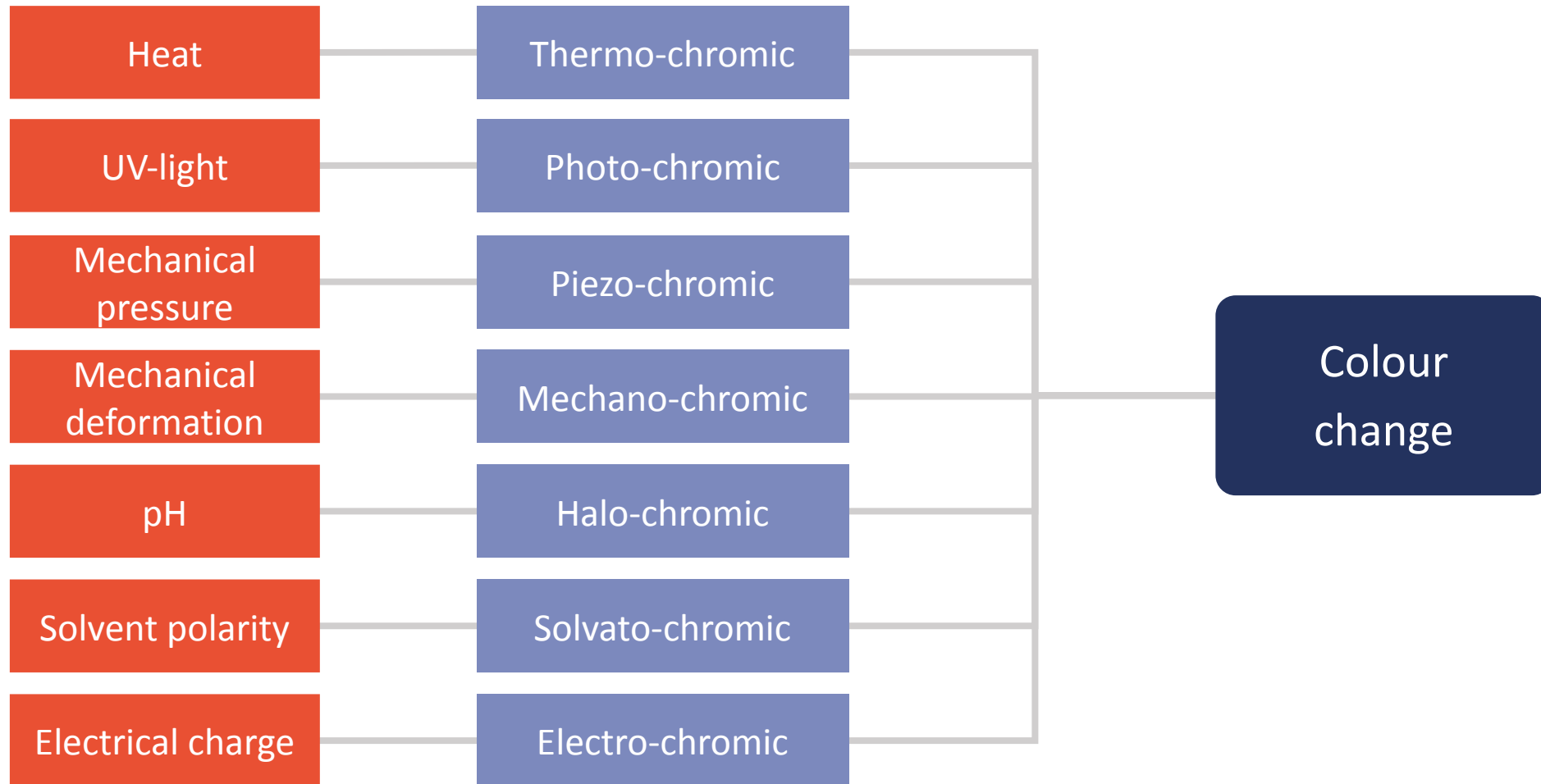


Contents

- Chromo-active textiles
- Phase Change Materials (PCMs)
- Shape memory materials
- Energy harvesting textiles

CHROMO-ACTIVE TEXTILES

Chromic responsive materials



Thermo-chromic textiles

INTRINSIC
SYSTEM

INDIRECT
SYSTEM

Thermo-chromic textiles

Liquid crystals

**INTRINSIC
SYSTEM**

Leuco-dyes

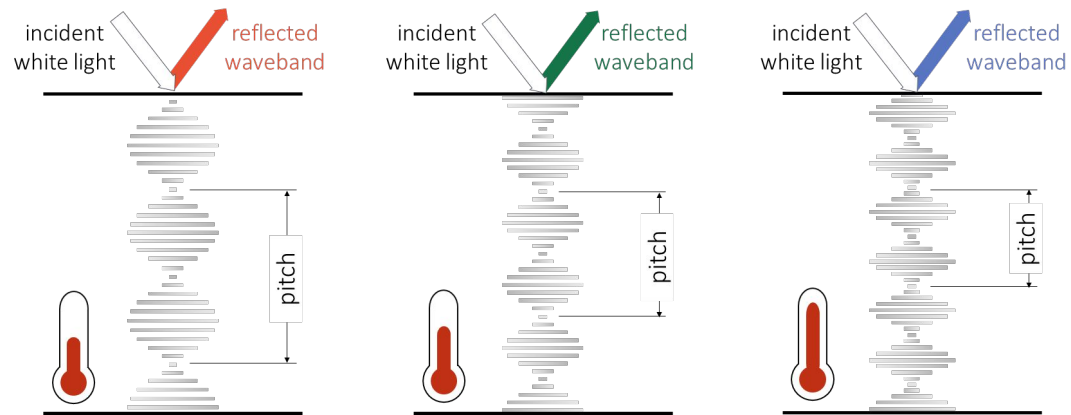
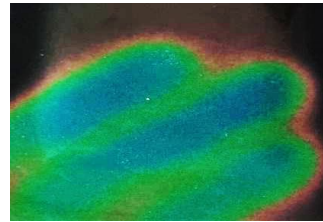
**INDIRECT
SYSTEM**

Thermo-chromic textiles

Liquid crystals

INTRINSIC SYSTEM

- Colour gradient



Leuco-dyes

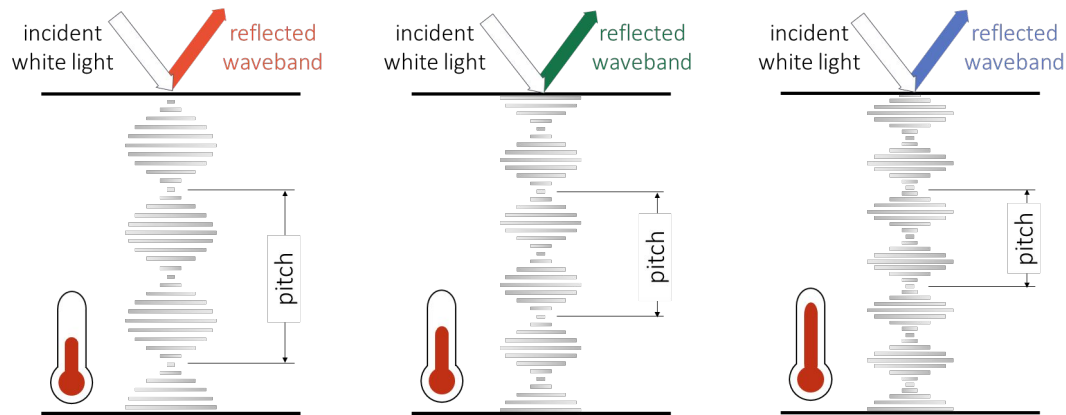
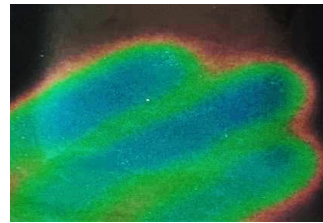
INDIRECT SYSTEM

Thermo-chromic textiles

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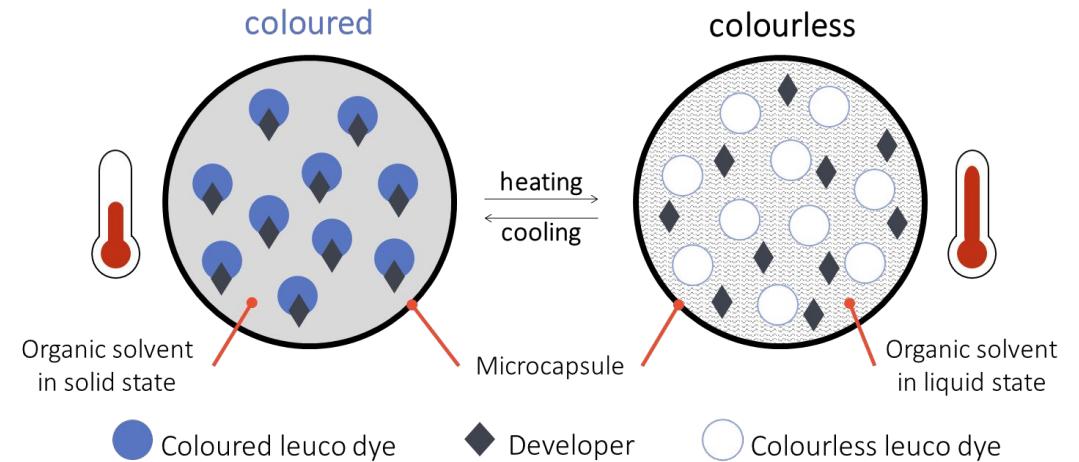
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Leuco-dyes

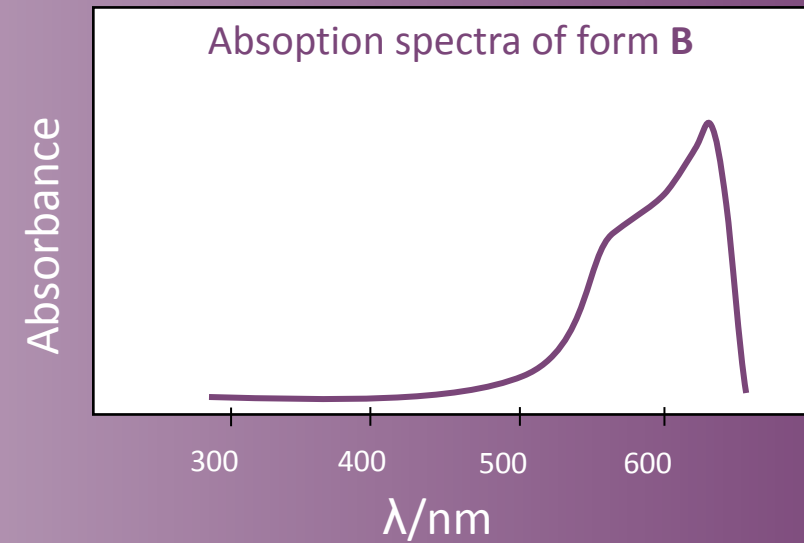
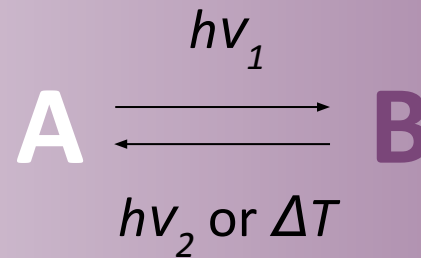
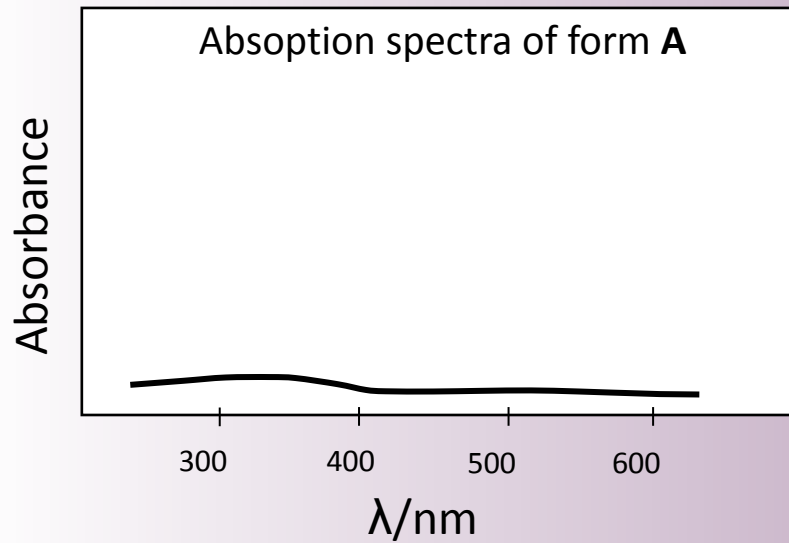
INDIRECT SYSTEM

- From coloured to colourless



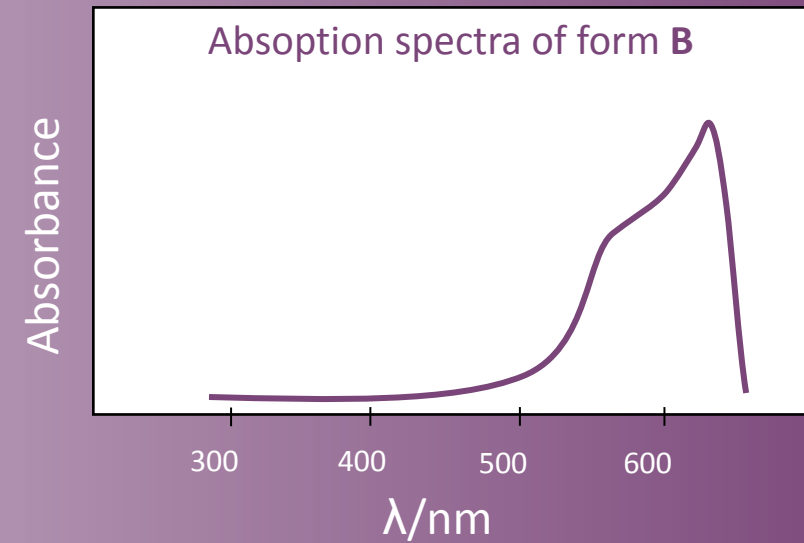
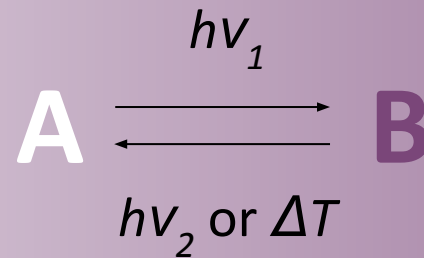
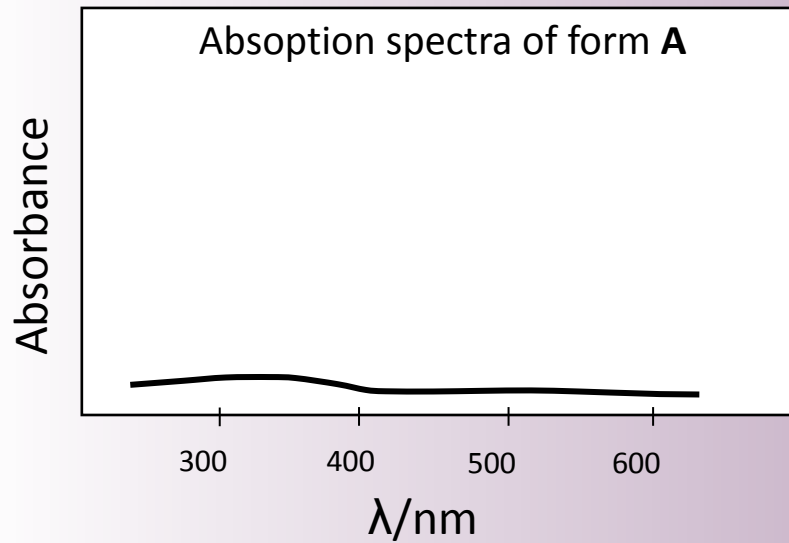
Photochromic textiles

- Photochromism = reversible light-induced colour change



Photochromic textiles

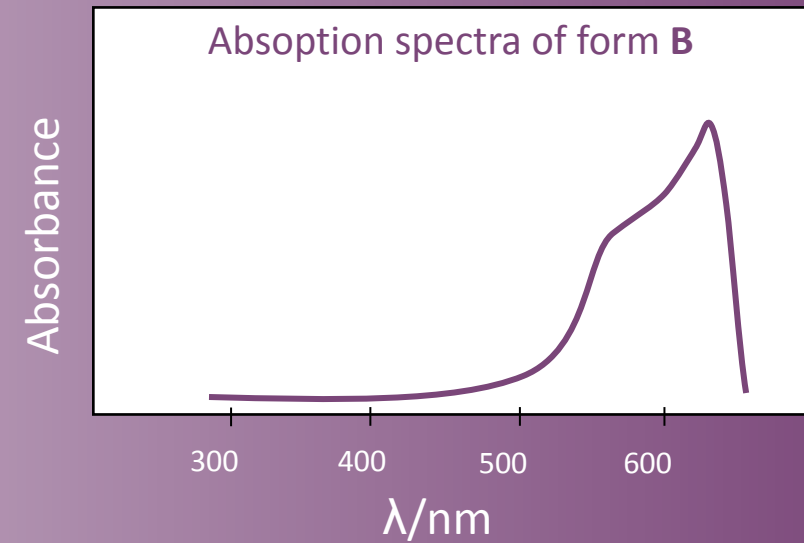
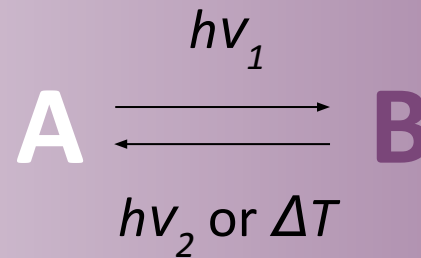
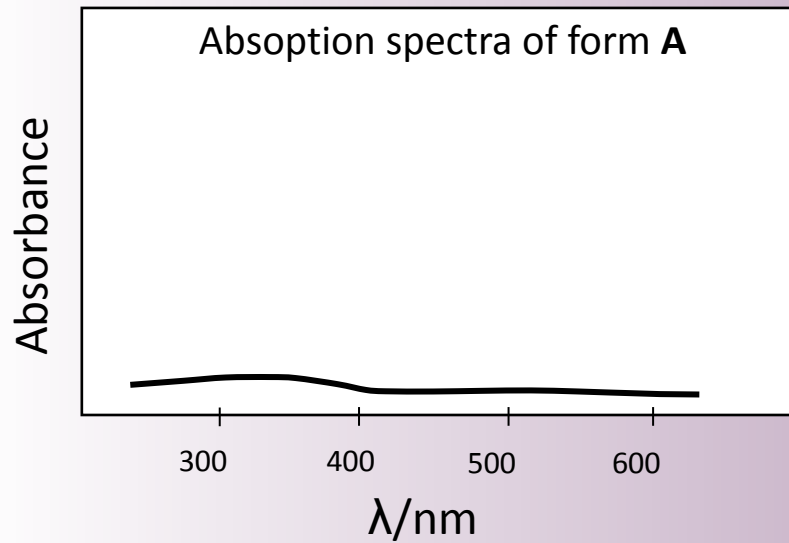
- Photochromism = reversible light-induced colour change



• Photochromism of **type T**

Photochromic textiles

- Photochromism = reversible light-induced colour change



Photochromism of **type P**

Photochromism of **type T**

PHASE CHANGE MATERIALS

Phase change materials (PCMs)

- Microencapsulated PCM

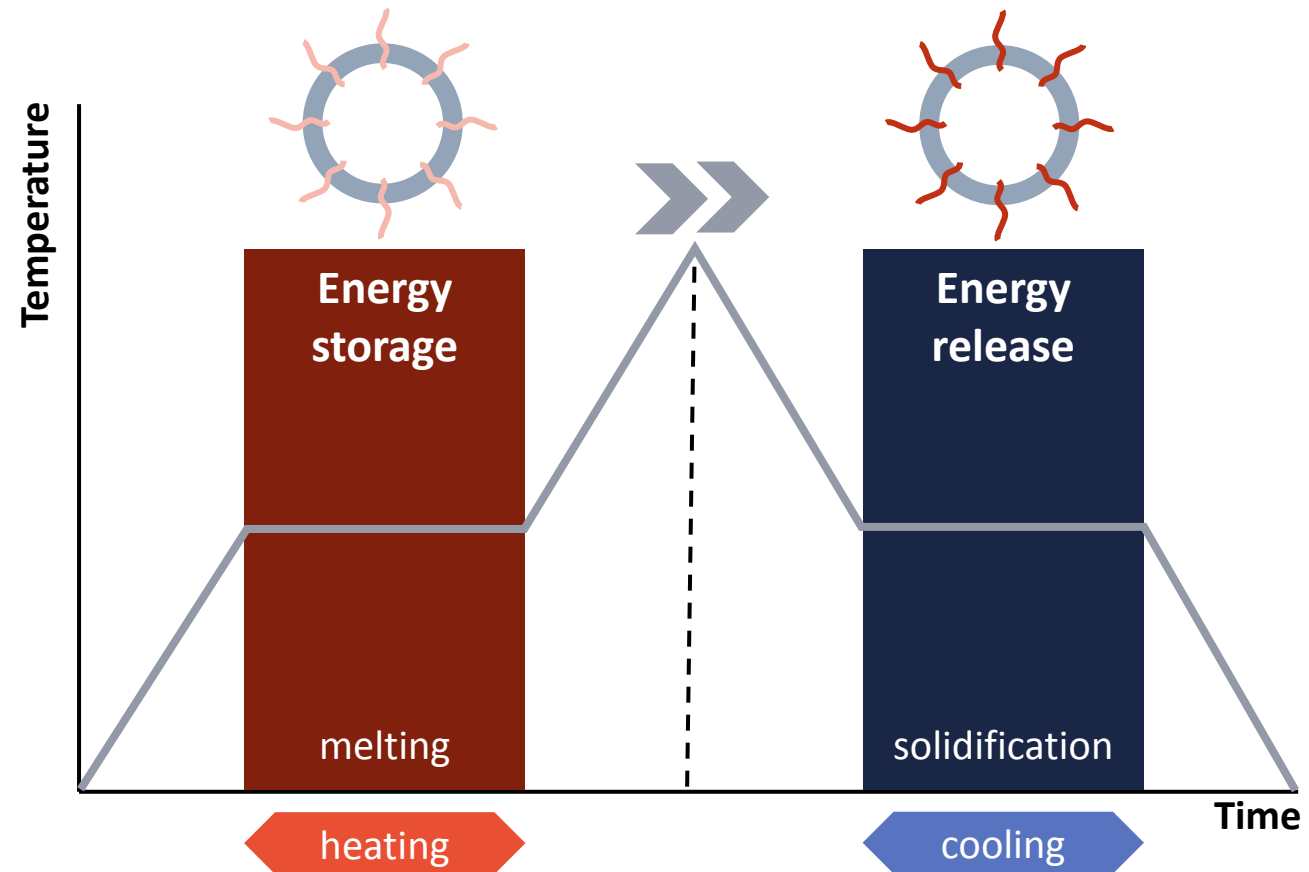


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Phase change materials (PCMs)

- Microencapsulated PCM

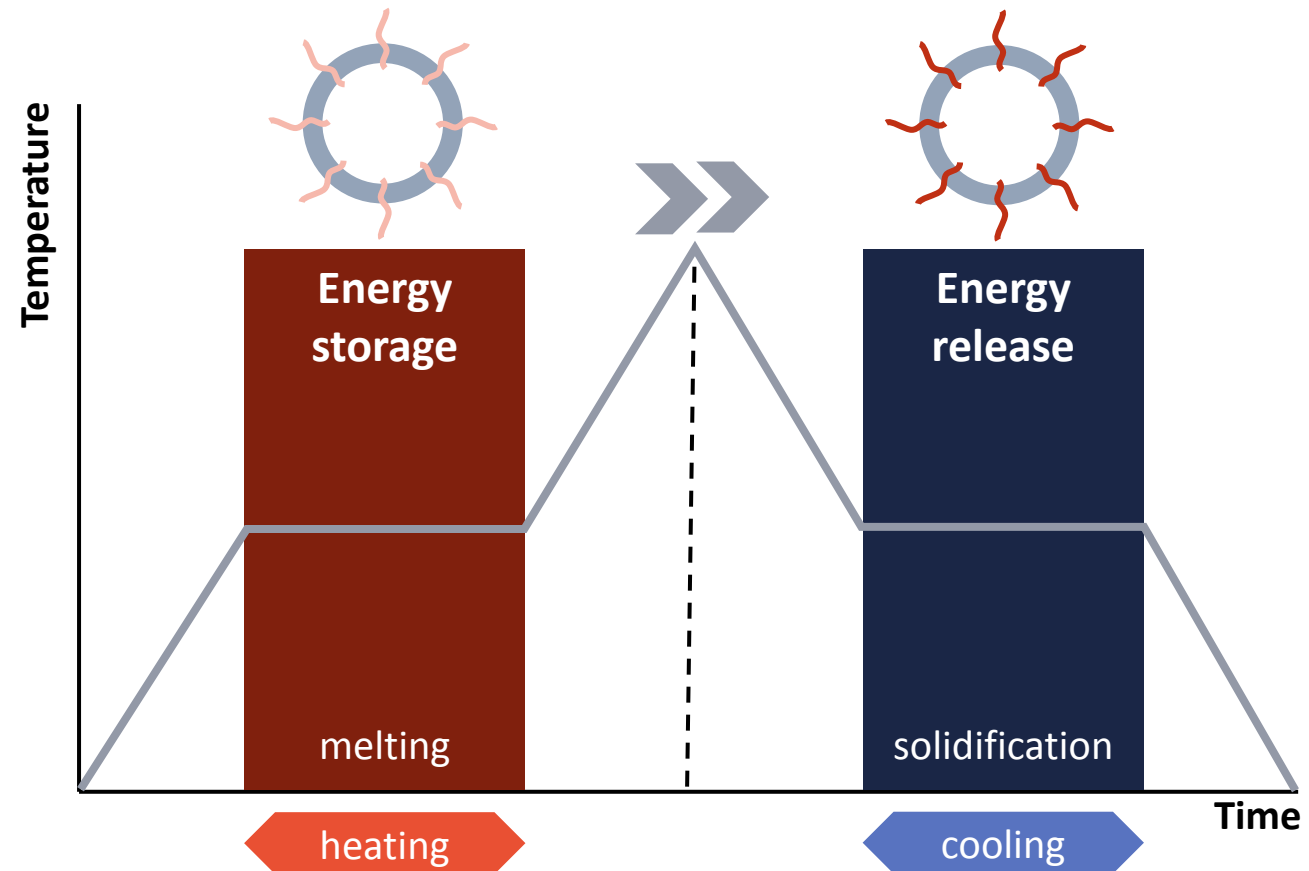
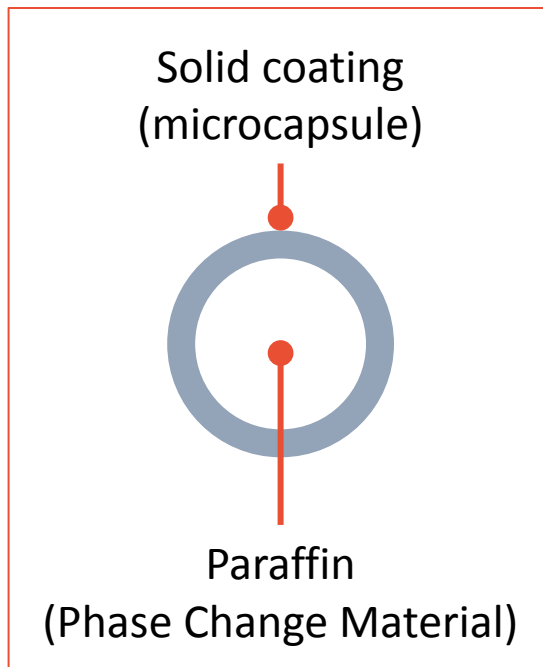


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SHAPE MEMORY MATERIALS



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Shape Memory Alloys (SMAs)

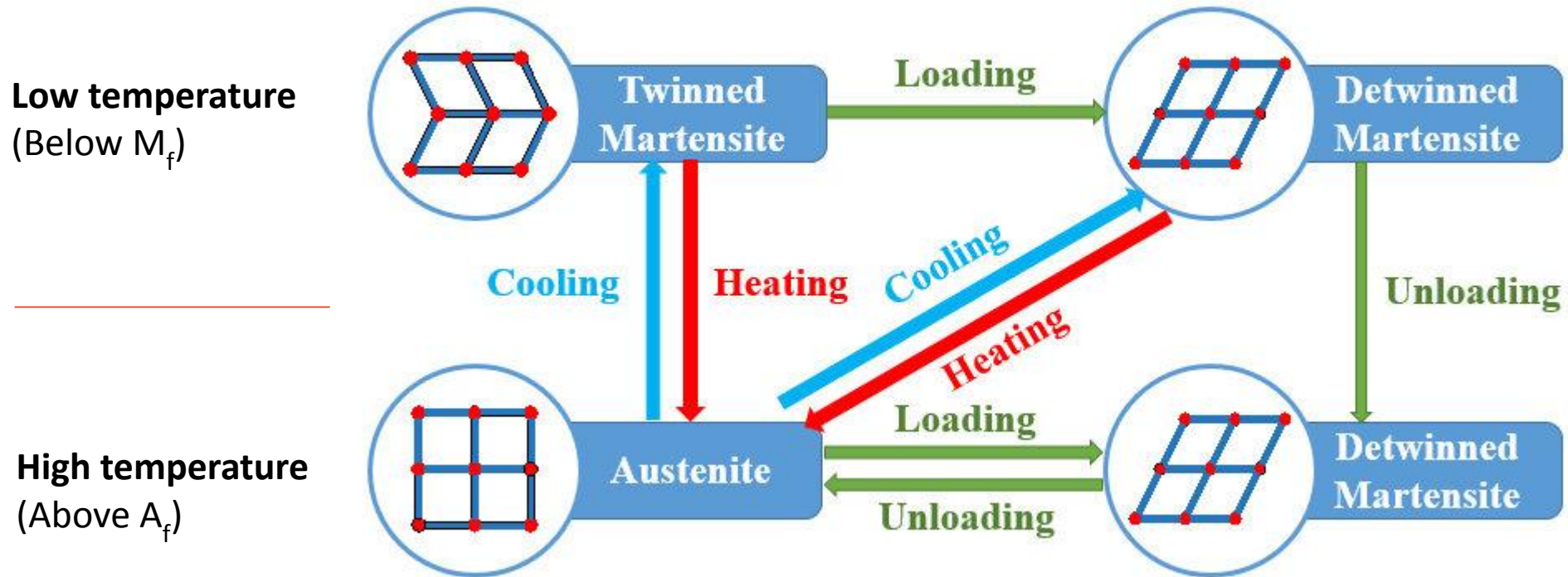


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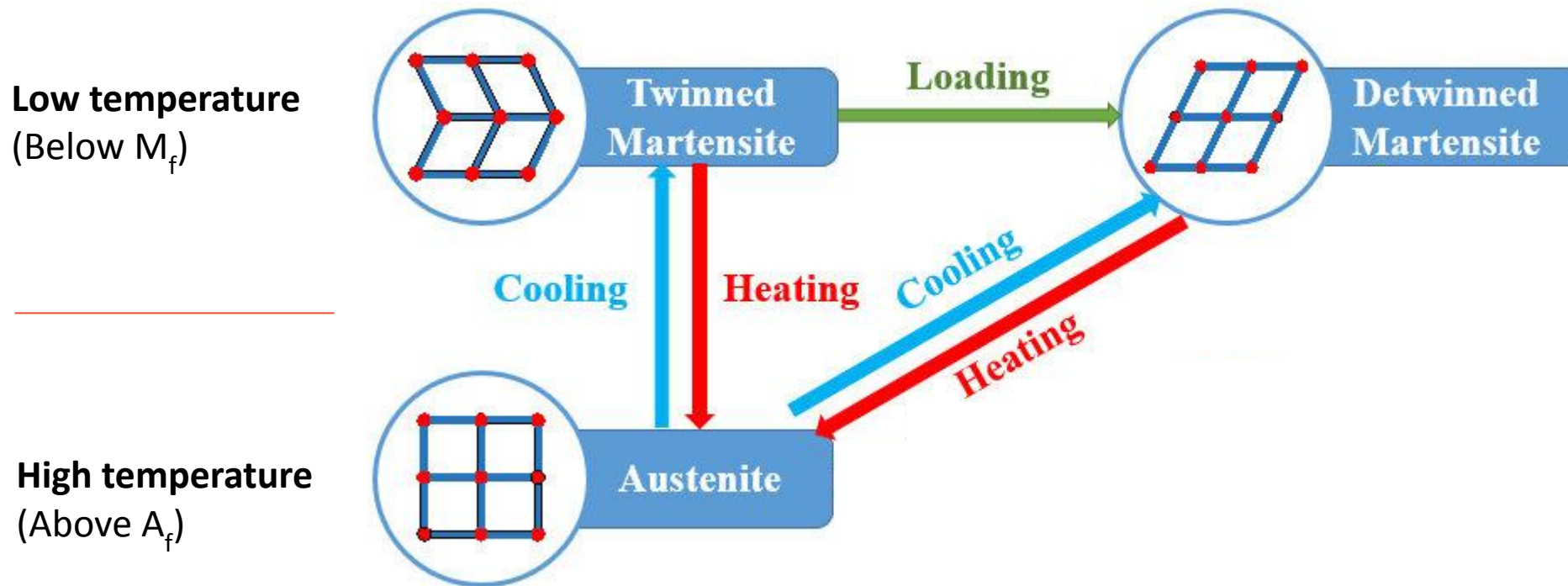


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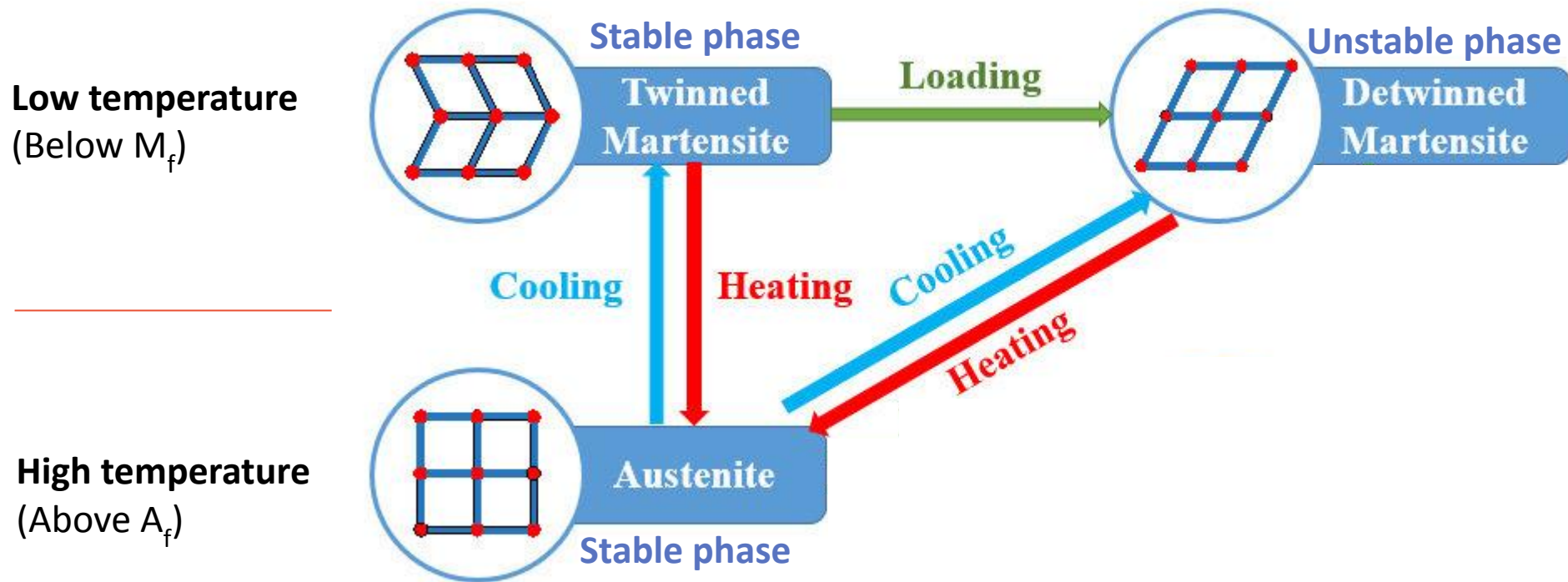


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Shape Memory Polymers (SMPs)

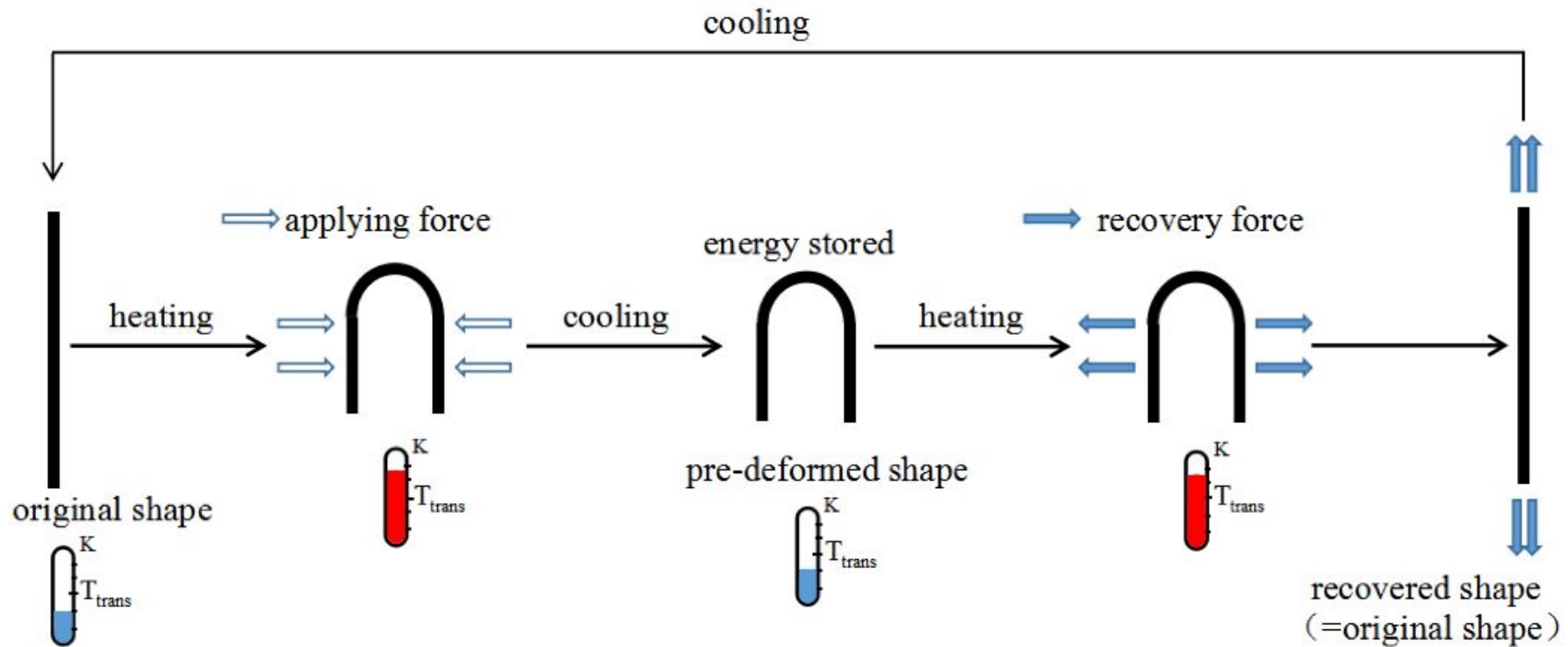


Image by Z. Wang, J. Liu, J. Guo, X. Sun, and L. Xu, CC BY "The Study of Thermal, Mechanical and Shape Memory Properties of Chopped Carbon Fiber-Reinforced TPI Shape Memory Polymer Composites," *Polymers* (Basel), vol. 9, no. 11, p. 594, Nov. 2017.

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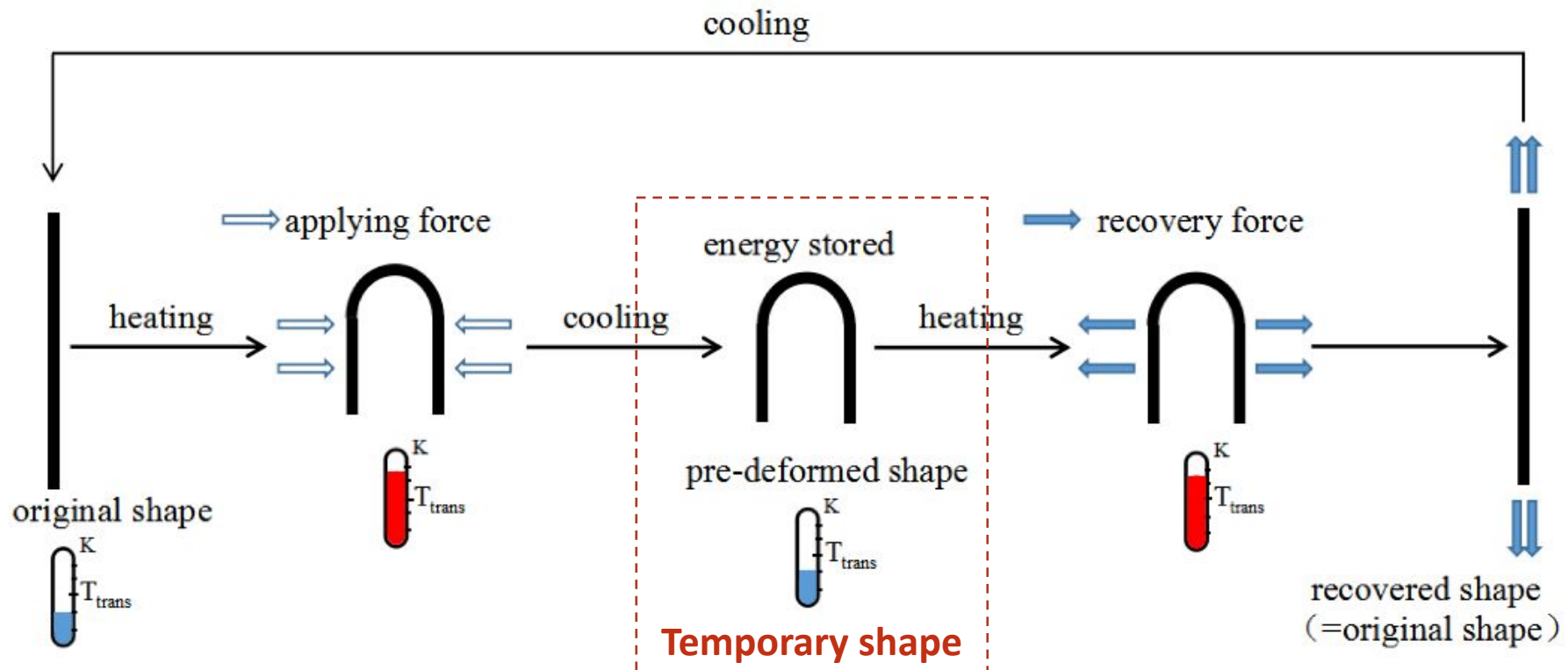
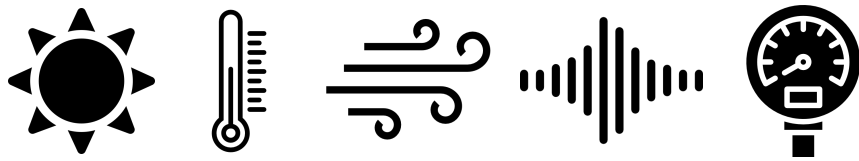


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ENERGY HARVESTING TEXTILES

Electric responsive materials

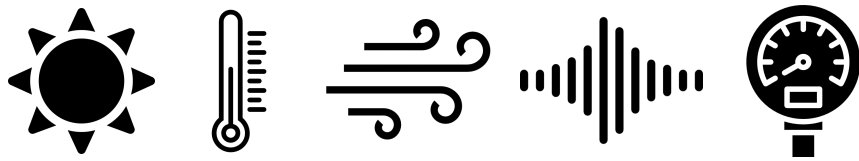
- **Energy harvesting:** collection of energy produced from renewable sources and easily found on our surroundings



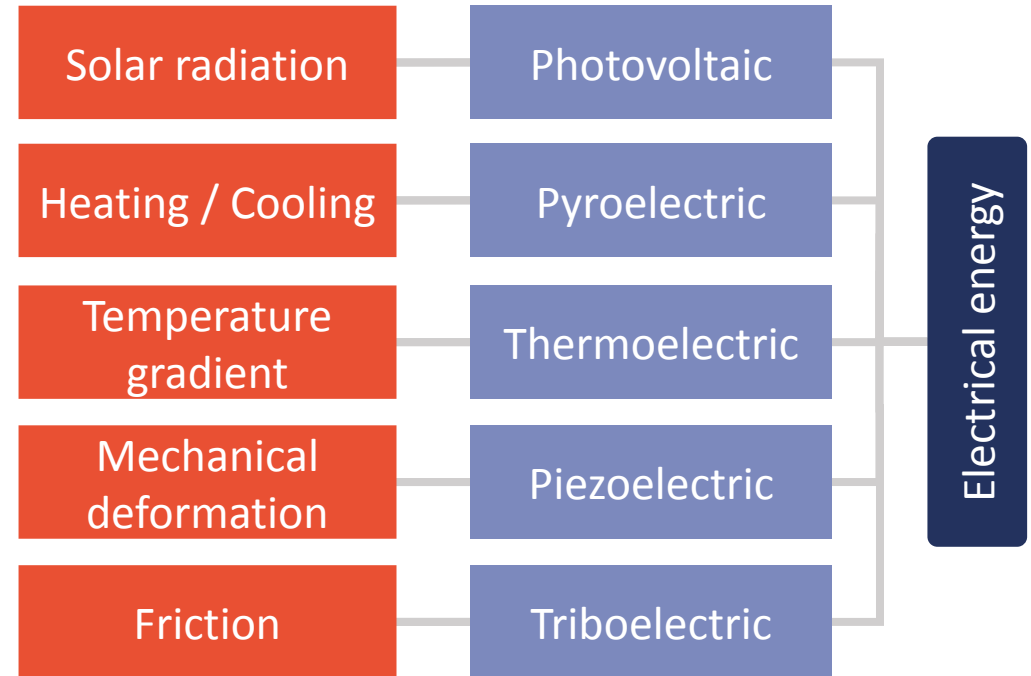
- Electric responsive materials react to external stimuli converting it into electrical energy.
- Therefore, they can be used for energy harvesting.

Electric responsive materials

- **Energy harvesting:** collection of energy produced from renewable sources and easily found on our surroundings



- Electric responsive materials react to external stimuli converting it into electrical energy.
- Therefore, they can be used for energy harvesting.



Piezoelectric and **triboelectric** more independent of the environmental conditions

Piezoelectric

- Pressure, stretch or twist generates electrical energy
- Polymer-based most suitable for textile applications: formation of dipoles due to the distribution of polymer chains
- PVDF on the crystalline form I (β -phase) achieved by doping and/or induction

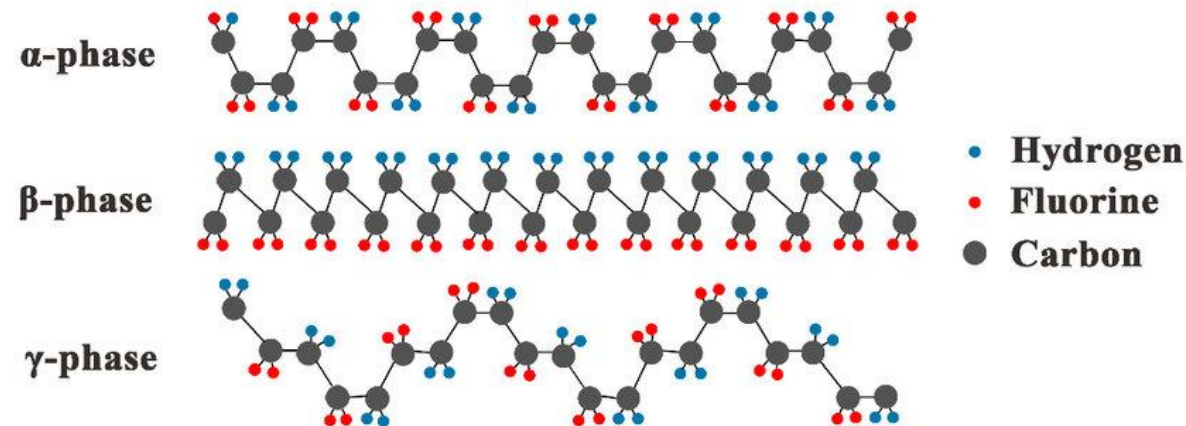
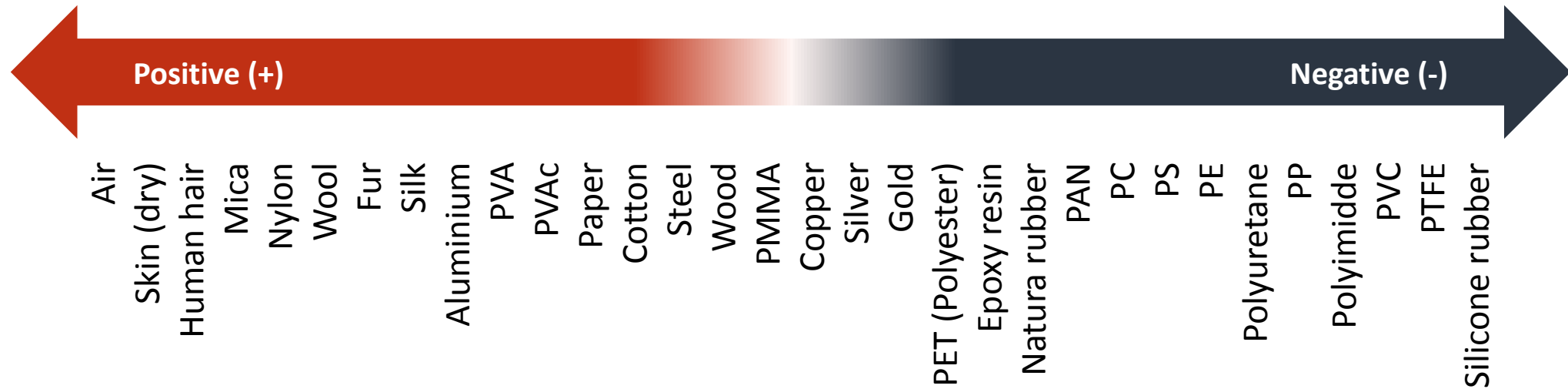


Image by Ting Wu et al. CC BY 4.0 "A Flexible Film Bulk Acoustic Resonator Based on β -Phase Polyvinylidene Fluoride Polymer," *Sensors*, vol. 20, no. 5, p. 1346, Feb. 2020.

Triboelectric

- Electrical energy generated by rubbing between two materials.
- An electrical charge transfer from one material to the other occurs. Produces high voltage
- Triboelectric series: ranked materials based on their tendency to gain (negative) or lose charges (positive) (higher difference, higher transferred during the contact)



Summary

In this lecture you have reviewed:

- Raw materials to generate colour response actuators in textiles (thermal- and light- induced)
- Phase change materials useful to provide thermal-regulation in smart textiles
- Shape memory alloys and polymers working principles that can lead to the production of actuators for smart textile solutions
- Piezoelectric and triboelectric raw materials related to energy harvesting

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Project:

Innovative smart textiles & entrepreneurship
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